

The Role of GenuTrain[®] in the Management of Knee Pain & Instability

GenuTrain[®] is an elastic knee support featuring a silicon patellar ring and an ideal anatomical adaptation to the knee joint. This is particularly important because the form determines function and efficiency during rehabilitation. The causes of knee pain and instability are often inter-related. By improving sensorimotor function and inhibiting pain, the effect of GenuTrain[®] enhances muscle recruitment and knee stability. By comparing differences of limb EMG activities the subjective benefits, reported by patients participating the field testing, can be substantiated. There is a consistent relationship between the magnitude of improvement (WOMAC pain score) and the specific constructive features of GenuTrain[®]. The indications of GenuTrain[®] include therapy, rehabilitation and even training for sports.

Rotating a joint stretches the soft tissues on one side of the joint and relaxes them on the other side. All the soft tissues around joints contain mechanoreceptors neurons that are activated by stretch. Thus stretch responses of mechanoreceptors potentially contain information about joint displacement or movements, and are therefore of interest to study motor control. Neurophysiological evidence that afferent information from skin receptors was important for proprioception was gathered first by experiments relating to the human hand and finger joints. ([Responses to passive movement of receptor in joint, skin and muscle of the human hand – Bublke D. Gandevia SC. Macefield G. – Journal of Physiology. 1988; 402:347-361](#)).

Edin however, confirmed that receptors in the hairy skin of humans can provide very reliable information about knee joint movements too. ([Cutaneous afferents provide information about knee joint movements in humans - Benoni B Edin – J Physiol. – 2001 Feb 15; 531 \(pt 1\): 289-297 -](#)).

This study was followed by others confirming that cutaneous receptors contribute to kinesthesia in all joints. Herewith, former clinical experiences about the contribution of taping and bracing to the stability of large joints -such as knee and ankle- could be experimentally explained and confirmed. Though taping and braces did not make any mechanical contribution to stability they improved conscious proprioceptive acuity and reduced subjective instability complaints.

Indeed, several reports claim that bracing and taping near the knee joint alone effectively improves a subject's proprioceptive acuity, whether the subject is healthy ([Perlau et al. 1995](#)),

has suffered cruciate ligament injuries ([Jerosch & Prymka, 1996](#)), or suffers from knee osteoarthritis ([Barrett et al. 1991](#)).

The physiological interaction between skin mechanoreceptors and elastic supports or taping has been investigated by several authors. Skin is a biaxial material, and stretching it creates biaxial states of tensile, compressive, and shear stress and strain.

When an elastic support immobilizes certain skin areas, movements always cause larger "tangential" strain than normal in other skin areas.

Further, relative displacements between skin and texture generate small frictions during joint movement. This condition is responsible for the vibrotactile stimulation described by Besmaïa et al. ([The vibration of texture – Besmaïa SJ. Hollins M. – Somatosens Mot Res. 2003; 20\(1\) :33-43](#)). and by Hollins et al. ([Evidence for the duplex theory of tactile perception .- Hollins M. – J. Perception Psychophys- 2000; 52:695-705](#)).

The comparative importance of strain, stress / pressure or vibrotactile stimulations is a matter of still ongoing speculations.

A third physiological interaction between elastic supports and skin is explained by the "Gate Control" mechanism. ([Pain Mechanism: A New Theory – Melzack R.; Wall P.; - Science: 150, 171-9, 1965](#)).

Pain can inhibit muscle contraction and therefore joint stability. Pain however can be inhibited by non-nociceptive signals such as the stretch and / or vibrotactile effects produced by the texture of elastic support.

This interaction can explain the stabilizing effects of elastic supports in inflammatory or degenerative conditions.

Product Features

THE “...Train®” CONCEPT

Movement always causes elastic supports to undergo an adaptation cycle involving adsorption – deformation – distribution phases.

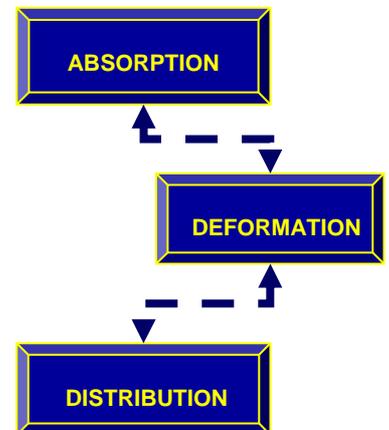
During each phase the relative movement between texture and skin activates slowly and fast adapting mechanoreceptors located in the perceptive field of **GenuTrain®**.

Tactile texture vibrations and skin displacement (stretch) are perceived by mechanoreceptors** eliciting a (better or) stronger afferent function during movement.

This adsorption – deformation – distribution cycle related with compression- are accomplished by:

- the silicon viscoelastic insert and
- the elastic treads.

The definition of “Train® active support” is based on the double effects of superficial interaction and the “deeper massage” resulting from compression.



Sophisticated manufacturing techniques are required to give GenuTrain® three specific features necessary to achieve the best possible sensomotoric effectivity (see pag.3):

- ❖ **Anatomical fitting allowing a non-slip fit and permanent contact with epidermal mechanoreceptors.**

Three-dimensional flat knitted fabric and integrated deformable soft silicon insert are necessary to maintain the contact with skin mechanoreceptors even in the peri-patellar area. Edema and hematoma reabsorption can be improved by the elastic deformation of the insert during flexion-extension.

- ❖ **Constant level of elastic tension (T) in order to achieve homogeneous levels of skin mechanical deformation and vibrotactile interactions during extension and flexion.**

Radial transversal variations, produced by muscular expansion during movement, account for the variable compression explained by the La Place law: $P=T/R$.

- ❖ **Maximal wearing comfort to avoid the interferences of nociceptor.**

Comfort is the result of many details including:

- Fold-free popliteal fitting (0-30°)
- Seamless (but elastic) welding of inserts
- Compression-reduced borders
- Breathable / moisture dissipating knitting
- 7 Sizes + made to measure



Indications

GenuTrain® increases knee joint stability by two different and coexisting physiological pathways:

- 1) - Improvement of muscular recruitment and
- 2) - Improvement robustness of feedback control.

Muscular recruitment is mainly the result of pain relief because pain inhibits (or reduces) motor unit firing and muscle contraction.

(Inhibition of motor unit firing during experimental muscle pain in humans –Sohn MK.; Graven-Nilsen T.; Svensson P.; - Muscle Nerve 2000 Aug; 23(8):1219-26)

Consistent with the “gate control mechanism” the skin contact with the support generates tactile stimulations interfering (with) and reducing pain perception.

(Pain Mechanism: A New Theory –Melzack R.; Wall P.; - Science: 150, 171-9, 1965)

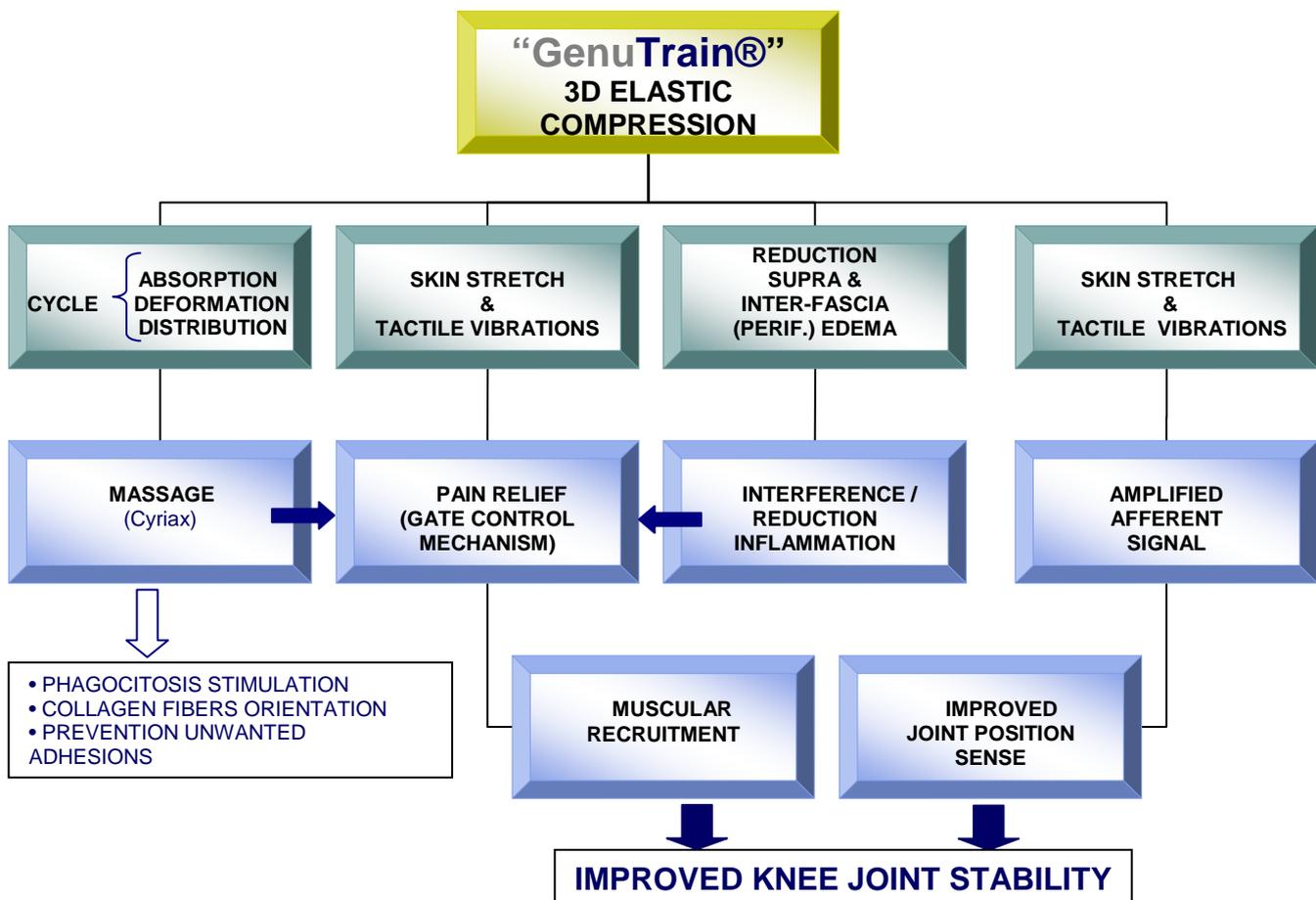
Pain can also be decreased by elastic compression indirectly. By reducing peripheral edema (at capillaries, supra and inter-fascia levels) the inflammatory process (involving

eritema, edema, tenderness and pain) is inhibited and pain prevented.

Further, consistent with the Cyriax approach,

(The Knee – Cyriax J. Physiotherapy -1971 May; 57(5):203-6; Deep Massage – Cyriax J - Physiotherapy – 1977Feb.63 (2):60-1) the “Train” massage effect – the intensity of which depends on muscle expansion- contributes to stimulation of phagocytosis, collagen fiber orientation, prevention of unwanted adhesions and increased blood flow and vasodilatation.

The second (proprioceptive pathway) results from the stretch and vibrotactile interactions with the skin mechanoreceptors. This improves a subject’s proprioceptive acuity, whether the subject is healthy *(The effect of elastic bandages on human knee proprioception in the uninjured population – Perlau R. Frank C, Fick G – Am J Sport Med 1995 Mar-Apr; 23(2):251-5)*. has suffered cruciate ligament injuries *(Jerosch & Prymka, 1996)*, or suffers from knee osteoarthritis *(Barrett et al. 1991; Barrack et al 1994.)*.



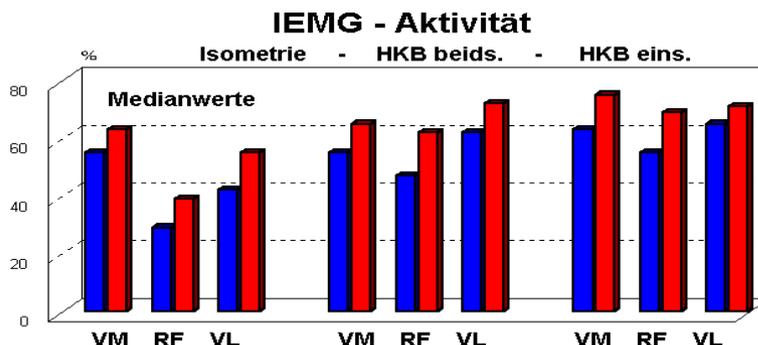
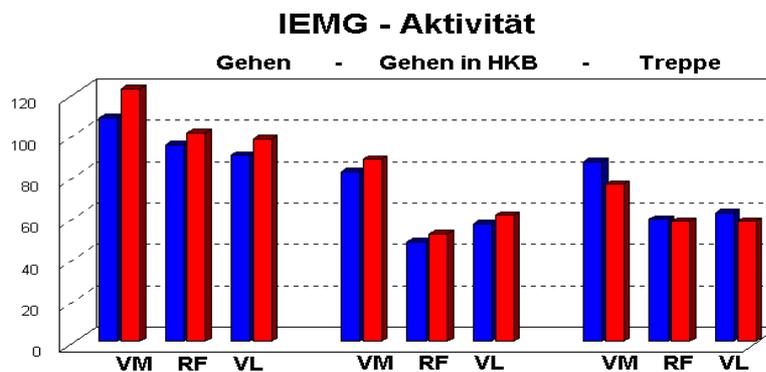
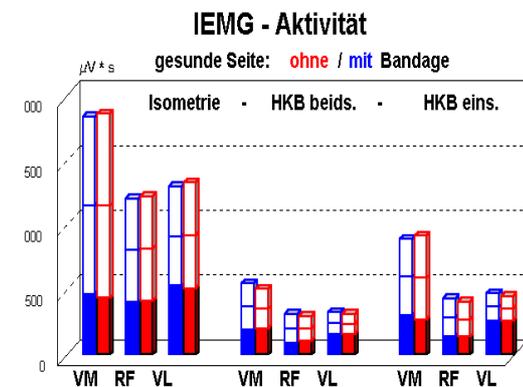
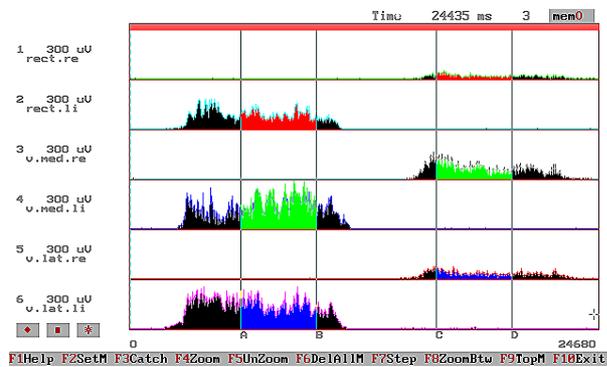
The influence of knee support on muscular recruitment was investigated (Laube et al. 1994b, Laube & Bochdansky 2002). on a patient with cross ligament reconstruction. In post operative week 7, during maximal voluntary contraction (MVC – Fig.1) and during standing in half knee bend with complete shifting of body weight to the healthy and injured side, EMG was performed. The corresponding deficit of strength was 45% (common for this stage of therapy). Before investigating the influence of the knee support, the absolute activation of quadriceps muscle components, of the healthy side and of

the injured side was showing no difference of infrapatellar pressure with and without the support. Fig.2.

Wilcoxon test revealed no statistical difference test and retest for healthy knee.

Quantitative EMG activation, on the ACL-reconstructed knee, was reduced in both tests. (Fig.3 and 4).

Median values of EMG activations of the healthy and injured side for these three tests showed a significant reduction of the asymmetrical limb differences, in terms of an increase of activation in the injured leg, wearing the knee support.



Important Statements

The role of the knee brace in the prevention of anterior knee pain syndrome.

BenGal S, Lowe J, Mann G, Finsterbush A, Matan Y. - Am J Sports Med. 1997 Jan-Feb; 25(1):118-22.

Our prospective study evaluates the use of a knee brace with a silicon patellar support ring **GenuTrain®** as a method of preventing anterior knee pain from developing in young persons undergoing strenuous physical exercise. Prophylactic use of the brace, as described, did not reduce the ability of the athletes who wore braces to improve their physical fitness parameters in response to exercise. These data indicate that the use of a brace may be an effective way to prevent the development of anterior knee pain syndrome in persons participating in strenuous and intensive physical exercise.



The effect of a sleeve on knee joint position sense.

Herrington L, Simmonds C, Hatcher-J. Res Sports Med. 2005 Jan-Mar; 13(1):37-46.

The findings of this study support the previous literature, which indicates that the application of a knee sleeve improves proprioceptive acuity.

The effect of elastic bandages on human knee proprioception in the uninjured population.

Perlau R, Frank C, Fick G.- Am J Sport Med. 02/ 1995

Results showed that elastic bandages significantly improved knee joint proprioception in the uninjured knee during the entire interval of their use (mean decrease in inaccuracy of 1.0 degree, equivalent to 25% improvement, $P < 0.05$), and that this benefit was lost when the bandage was removed. The magnitude of the improvement, or the potential beneficial effect of the bandage, was inversely related to the participant's inherent knee proprioceptive ability, which was demonstrated in the test group before the initial application of the bandage.

Knee bracing: effects of proprioception.

McNair PJ, Stanley SN, Strauss GR. Arch Phys Med Rehab. 1996 Mar; 77(3):287-9.

RESULTS: The findings showed that there was an improvement of 11% in tracking when subjects wore the knee brace ($p < .05$). CONCLUSION: Alterations in proprioception as a result of bracing may be partly responsible for the improvement in knee injury statistics reported in some studies.

The benefits of wearing a compression sleeve after ACL reconstruction.

Kuster MS, Grob K, Kuster M, Wood GA, Gachter A. Med Sci Sport Exerc 1999;31:368-71.

CONCLUSIONS: It was concluded that a compression sleeve improved the total integration of the balance control system and muscle coordination.

Proprioceptive capabilities in patients with retropatellar knee pain under special consideration of the influence of an elastic knee-brace.

Jerosch et al., Unfallchirurg 1997;100

With a worn brace patients showed improved reproduction capacities of given angles during knee joint movement.

Conclusion

GenuTrain[®] is much more than a good-looking knee support. It is the result of a constant interdisciplinary cooperation between rheumatologist, orthopaedic and rehabilitation physicians with the Bauerfeind Innovation Centre (BIC).

Six versions of this support have been developed, so far, in order to achieve the best possible WOMAC pain scores (compared with medical treatment alone) in the management of knee injury and osteoarthritis. The results, when comparing previous GenuTrain[®] versions, confirm also that manufacturing evolution is justified by significant improvement of efficiency toward less pain / instability, and better functional status.

These findings were confirmed by EMG when comparing ACL-deficient or ACL-reconstructed patients.

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